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(54) **Friction materials and their uses.**

(57) The invention concerns a composition for a friction material, e.g. for a brake lining or clutch facing, of the type containing a fibrous reinforcement, a binder and various additives.

The friction material contains no asbestos, but has properties comparable with asbestos-based materials. The composition contains a thermoset binder, which may be based on a phenol-formaldehyde resin, or a heat and chemical resistant rubber, the binder making up 15 to 40% by volume of the material. The fibrous reinforcement is a mixture of an inorganic fibre selected from metal fibres, e.g. steel glass fibre, mineral wools manufactured from slags or naturally occuring rocks such as basalt, silica fibres and ceramic fibres of the alumino silicate type; with at least one organic fibrous material such as wood pulp, jute, sisal, cotton.

70 to 4% by volume of the material consists of the fibrous reinforcement, preferably 50 to 10% by volume. The inorganic fibrous material is the main reinforcement of the friction material, the organic fibrous material providing integrity and strength during manufacture.

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This invention relates to friction materials, and more particularly to friction materials of the kind used for clutch linings, brake linings and similar uses.

Friction materials of this kind are generally composed of a thermoset binder, a fibrous reinforcement, generally asbestos, and various fillers and other additives. Proposals have been made regarding the replacement of asbestos with other materials but without complete success owing to the severe operating temperatures and pressures which the materials are required to withstand under repeated application without failure or deterioration in friction properties.

According to the present invention a friction material comprises a thermoset binder, a fibrous reinforcement and other fillers and additives, the thermoset binder making-up 15 to 40 per cent by volume of the material, and the fibrous reinforcement making up 70 to 4 per cent by volume of the material the fibrous reinforcement comprising a mixture of at least one inorganic fibrous material selected from metal fibres; glass fibre; mineral wools manufactured from slags or naturally occurring rocks such as basalt; silica fibres and ceramic fibr s of the alumino-silicate type; with at least one organic fibrous material.

Preferably the fibrous reinforcement constitutes 10 to 50 per cent by volume of the friction material.

The preferred amount of inorganic fibrous material is in the range 3 to 40 per cent by volume of the material, and the preferred amount of organic fibrous material is in the range 3 to 18 per cent by volume of the material.

In general when the inorganic fibrous material is in the form of metal fibres such as steel fibre its amount will preferably be in the lower end of the preferred range e.g. 3 to 15 per cent by volume, whilst when the inorganic fibrous material is in the form of glass fibre its amount will preferably be in the higher part of the preferred range e.g. 9 to 40 per cent by volume.

The organic fibrous material consists of short lengths of fibre and may comprise cellulose fibres from sources such as wood pulp, jute, sisal, or cotton linters. A function of the organic fibrous material is to convey green strength to the material during production, and to this end the organic fibres must be opened fibre, when natural products are used. Thus wood pulp is a suitable organic fibrous material whilst wood flour is not since the fibres of the wood are bound tightly by resin and wood flour acts only as a filler.

The inorganic fibrous material is also in the form of short lengths of fibre and is the main reinforcement of the friction material. Where mineral wool is being used as the inorganic reinforcement it is preferred that it contains a minimum of the small non-fibrous agglomerates of mineral usually referr d to as shot. Where it is desired to use large quantities

of glass fibres in a particular formulation it is advantageous to use milled glass fibres or chopped strand glass i.e. glass in the form of continuous bundles of fine glass filaments, bound together with coatings of sizes commonly used by the glass fibre industry, then chopped into short strands composed of a multitude of fine parallel filaments. The preferred chopped strand length is 3 to 13mm. However, shorter fibres may be used if desired. It is also desirable to use glass whose individual filaments are coated with a coupling agent applied during the manufacturing process to improve the bond between the glass and the thermoset binder.

The preferred metal fibre is steel fibre, which may be mild steel and is preferably in the form of short lengths of fine steel fibre e.g. diameter of the order of 0.125mm and length in the range 1 to 5 mm.

In the friction material the binder is preferably an organic binder, for example a thermosetting resin such as a phenol-formaldehyde resin, or a heat and chemical resistant natural or synthetic rubber such as nitrile rubber.
Preferably the binder comprises a phenol-formaldehyde resin, and more preferably a mixture of such a resin with a heat and chemical resistant cured rubber such as nitrile rubber.

The other fillers and additives in the friction material may be taken from a number of classes of such materials, and the nature and amount of each such material is chosen to achieve the particular d sir d cost/property combination. Inorganic particulate fillers such as barytes, whiting, rottenstone; reinforcing

fillers such as mica; friction and wear modifiers including lubricants such as graphite or molybdenum disulphide; antimony trisulphide, metals such as copper, zinc, brass or aluminium in the form of wires, turnings or particles may each be incorporated as desired. Friction dusts or particles composed of cured and ground thermoset resins or rubbers may also be added.

The compositions of the present invention which have total fibre contents below about 40% by volume are particularly suited to use in the method of producing friction materials which consists of

(a) intimately mixing all the ingredients of the composition together, uncured liquid resin binder serving to bind the compounded mass together or tacky uncured rubber binder serving the same purpose

(b) forming the composition into a sheet

(c) shaping the sheet where necessary (as in the manufacture of curved linings for drum brakes) and

(d) curing the material.

In this process the sheet is required to have adequate strength before curing and we have found that the organic fibres mixed with the inorganic fibres provide the necessary strength. This process is particularly suited to the production of brake linings.

Alternatively, particularly for those compositions which have a total fibre content above about 30% by volume th friction material of this invention is suitable for manufactur by a slurry technique in which the fibres, binder and other ingredients

are dispersed in water by means of a beater to form a pulp. The pulp is then formed into a sheet by deposition on a wire screen or felt and the water sucked out. The sheet is then dried, cut into desired shapes and cured by application of heat and pressure. This technique is particularly suited to the manufacture of clutch facings.

The invention will now be illustrated in the following Examples.

Examples 1 to 3

Annular clutch facings of outside diameter 152.4mm and inside diameter 127mm were manufactured by the slurry technique mentioned above from friction materials having the formulations given in Table I below, all quantities being given as parts by volume.

TABLE I

Example No.	1	2	3
Binder			
Phenol-formaldehyde resin	25	26	26
Fibrous materials			
Glass fibres (3mm-6mm)	40	25	-
Kaowool (Alumino-silicate fibre)*	-	-	30
Cellulose (wood pulp)	20	10	5
Fillers etc.			
Friction dust	-	17	17
Whiting	12	14	14
Antimony sulphid	-	5	5
Brass	3	3	3

* Kaowool is commercially available from morganite and that used had a fibre length 6mm.

The clutch facings produced, when run against a cast iron counterface on a small scale friction and wear testing machine, showed lower wear rates and higher coefficients of friction than similar materials containing asbestos.

The coefficients of friction determined were in the range 0.3 to 0.4 in a 203.2mm x 146.05mm coil spring clutch against a cast iron flywheel and pressure plate.

Example 4

An annular clutch facing, 203.2mm outside diameter, was manufactured by the slurry technique mentioned above from the formulation given in Table II below.

TABLE II

Ingredient	Parts by volume
Nitrile rubber latex	20
Phenol-formaldehyde resin	20
Milled glass fibres (190u nominal length 9-13u diam.)	30
Wood pulp	10
China clay	10
Sulphur	1
Bentonite	2
Ground rubber crumb	6

The clutch facings so produced had a burst strength of 11,000 tc 11,500rpm at ambient temperature and 6,750 to 8,000rpm at 200°C, (Burst strength is measured by rotating the clutch facing about its axis at increasing rpm until it breaks through centrifugal force), and a cross breaking strength of 75,842

to 82,737KN/m^2 (cross breaking strength is measured by placing a sample of the facing on two supports 25.4mm apart, and then measuring the load required midway between the supports to break the facing).

Example 5

An annular clutch facing 152.4mm outside diameter was manufactured by the slurry technique from the formulation given in Table III.

TABLE III

Ingredient	Parts by volume
Nitrile rubber latex	3.25
Phenol-formaldehyde resin	15
3mm long chopped strand glass fibre (304 tex)	25
Wood pulp	10
Whiting	21.25
Brass	3

The facings so produced had a burst strength of 10,000 to 12,500rpm at ambient temperature, and 7,000 to 7,500rpm at 200°C.

Example 6

An annular clutch facing of 203.2mm outside diameter was manufactured by the slurry technique from the formulation given in Table IV.

TABLE IV

Ingredient	Parts by volume
Phenol-formaldehyde resin	26
Milled glass fibre (190u nominal length, 9-12u diameter)	30
Wood pulp	10
Friction dust	17
Antimony trisulphide	2
Brass	3
Whiting	9
Sulphur	3

The facings so produced had a burst strength of 11,000 to 11,500rpm at ambient temperature and 9,250 to 9,750rpm at 200°C, and a cross breaking strength of 82,737KN/m2.

The previous Examples all illustrate the use of the friction materials of this invention in clutch facings. The following examples illustrate the use of the materials in brake linings.

Examples 7 to 16

Compositions were compounded to the formulations given below in Tables V, and VI rolled out into sheet form, shaped into a curved form suitable for brake linings, cured and made into sample brake linings. The curing was carried out in an oven at 238°C for a period of 90 minutes.

In each case the friction and wear properties of the material as determined on a 254mm x 69.85mm hydraulic 2 leading sho brak rig mounted on a dynamomet r w re found to b comparabl to conv ntional asbestos containing brake-linings.

In the tables below all quantities are given as parts by volume.

TABLE V

Example No.	7	8	9	10	11
Binder					
Liquid phenolic resin modified with cashew nut oil	25	25	27	24	27
Uncured powdered nitrile rubber	0	0	0	12	0
Dry resin-phenolic	5	10	4	0	7
Inorganic Fibre					
Steel (3 to 6mm staple)	0	0	3	3	0
Glass (3 to 13mm staple)	9	0	0	0	3
Organic Fibre					
Jute 9	9	9	9	9	9
Cotton	0	6	0	0	0
Fillers					
Wood flour	5	5	5	5	5
Whiting	20	20	20	20	20
Crumb rubber (cured)	2.5	5	5	5	5
Graphite	2.5	0	2.5	0	2
Disintegrated cured resin particle and dust	22	20	24.5	22	22
Coefficient of friction at 48KM.P.H. at 70°C	0.37	0.36	0.39	0.36	0.37

TABLE VI

Example No.	12	13	14	15	16
Binder					
Liquid phenolic resin modified with cashew nut oil	23.5	25.5	23.5	25	15
Uncured powdered nitrile rubber	0	0	4	0	15
Dry resin-phenolic	9.0	0	0	0	0
Inorganic Fibre					
Steel (3 to 6mm staple)	8.5	8.5	8.5	13.5	0
Glass (3 to 13mm staple)	0	0	0	0	25
Organic Fibre					
Jute	11.5	11.5	11.5	4.5	5
Fillers					
Whiting	19	26	24	19	14
Crumb rubber (cured)	5	5	5	4.5	3
Graphite	2.5	2.5	2.5	14.5	10
Disintegrated cured resin particle and dust	21	21	21	19	13
Coefficient of friction at 48 KM.P.H. at 70°C	0.40	0.39	0.42	0.43	0.32

CLAIMS:

1. A friction material comprising a thermoset binder, a fibrous reinforcement and other fillers and additives wherein the thermoset binder makes up 15 to 40% by volume of the material and the fibrous reinforcement makes up 70 to 4% by volume of the material, the fibrous reinforcement comprising a mixture of at least one inorganic fibrous material selected from metal fibres, glass fibre, mineral wools manufactured from slags or naturally occurring rocks, silica fibres and ceramic fibres of the alumino-silicate type with at least one organic fibrous material.

2. A friction material according to Claim 1 in which the fibrous reinforcement constitutes 10 to 50% by volume of the friction material.

3. A friction material according to Claim 1 or 2 in which the amount of inorganic fibrous material is in the range 3 to 40% by volume of the material.

4. A friction material according to Claim 1, 2 or 3 in which the amount of organic fibrous material is in the range 3 to 18% by volume of the material.

5. A friction material according to any one of the preceding claims in which the inorganic fibrous material is steel fibres and its amount is in the range 3 to 15% by volume of the material.

6. A friction material according to any one of Claims 1 to 4 in which the inorganic fibrous material is in the form of glass fibre and its amount is in the range 9 to 40% by volume of the material.

7. A friction material according to any one of th preceding claims in which the organic fibrous material comprises short lengths of fibre and is a natural fibre.

8. A friction material according to Claim 7 in which the fibre comprises wood pulp, jute, sisal or cotton.

9. A friction material according to any one of the preceding claims in which the binder comprises a phenol-formaldehyde resin.

10. A friction material according to any one of the preceding claims in which the binder includes a heat and chemical resistant rubber.

11. A friction material according to Claim 10 in which said rubber is nitrile rubber.

12. A friction material according to any one of the preceding claims which comprises at least one inorganic particulate filler.

13. A friction material according to any one of the preceding claims which includes one or more friction or wear modifiers selected from graphite, molybdenum disulphide, antimony trisulphide and copper, zinc, brass and aluminium.

14. A clutch facing comprising a friction material as claimed in any one of the preceding claims.

15. A brake lining comprising a friction material as claimed in any one of the preceding claims.

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EUROPEAN SEARCH REPORT

0000840
Application number

EP 78 30 0259

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 3 007 890 (S.B.TWISS) * Column 3, lines 59-63; column 4, lines 64-65; column 6, lines 29-51; column 8, lines 37-46 *	1,2,5, 6,8,9, 10,11, 12,13, 14,15
	FR - A- 2 035 404 (KELSEY-HAYES) * Page 4, lines 1-10 and 22-40; page 5, lines 15-20 and 27-40; page 6, lines 1-19 *	1,2,9 to 14
A	FR - A -2 208 487 (JOHN MANVILLE) * Page 1, lines 31-38; page 2, lines 18-36; page 3, lines 11-40; page 4, lines 7-37, examples 1-6 and 9-14 *	
A	FR - A - 1 363 324 (DE VINZELLES) * Page 1, left-hand column, first paragraph; abstracts 1,2 *	

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

F 16 D 69/02
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TECHNICAL FIELDS SEARCHED (Int.Cl.²)

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CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14-11-1978	SOULON

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